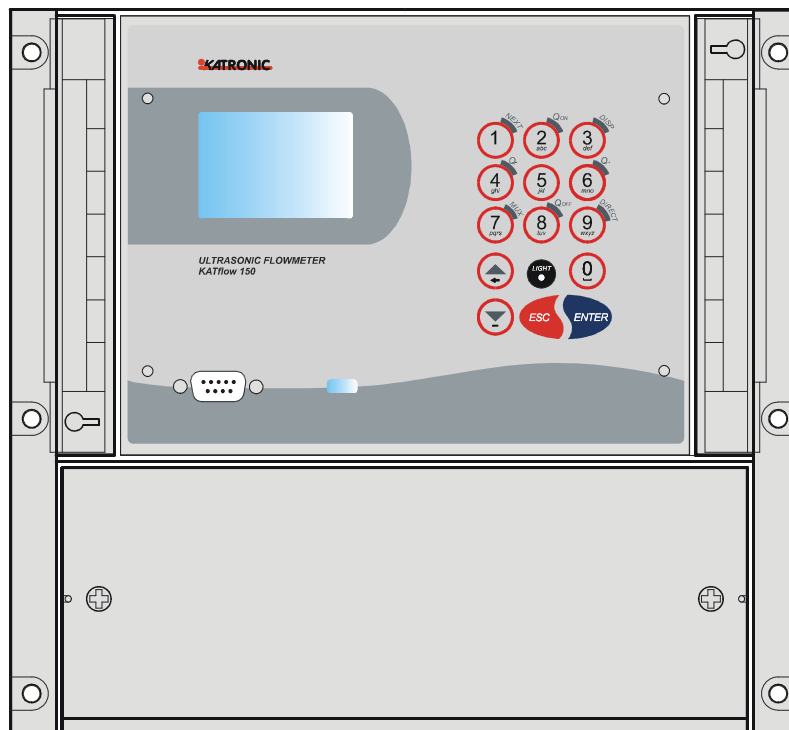


## Operating Instructions



## Ultrasonic Flowmeter **KATflow 150**

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**Operating Instructions KATflow 150**

Version V10E0608

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# KATflow 150

## Operating Instructions

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# 1 Safety instructions, legal requirements, warranty, return policy

## 1.1 Symbols used in these operating instructions



### Danger

This symbol represents an immediate hazardous situation which could result in a **serious injury, death or damage to the equipment**. Where this symbol is shown, do not use the equipment further unless you have fully understood the nature of the hazard and have taken the required precautions.



### Attention

This symbol indicates important instructions which should be respected in order to avoid damage or destroy the equipment. Follow the the precautions given in these instructions to avoid the hazard. Call our service team if necessary.



### Call service

Where this symbol is shown call our service team for advise if necessary.



### Note

This symbol indicates a note or detailed set-up tip.



This symbol represents enumeration.



Operator keys are printed in bold typeface and placed in pointed brackets.

## 1.2 Safety instructions

- Do not install, operate or maintain this flowmeter without reading, understanding and following these operating instructions, otherwise injury or damage may result.
- Study these operating instructions carefully before the installation of the equipment and save them for future reference.
- Observe all warnings, notes and instructions as marked on the packaging, on the equipment and those detailed in the operating instructions.
- For mains powered equipment, protective earthing must be connected.
- Do not use the instrument with removed or opened covers/doors under wet conditions.
- Consider the unpacking, storage and preservation instructions to avoid damage to the equipment.
- Install the equipment and cabling securely and safely according to the respective regulations in place.
- If the product does not operate normally, please refer to the service and trouble shooting instructions or contact KATRONIC for help.

### 1.3 Warranty

- Any product purchased from KATRONIC is warranted in accordance with the relevant product documentation and as specified in the sales contract provided it has been used for the purpose for which it has been designed for and operated as outlined in these operating instructions. Misuse of the equipment will immediately revoke any warranty given or implied.
- Responsibility for suitability and intended use of this ultrasonic flowmeter rests solely with the user. Improper installation and operation of the flowmeter may lead to a loss of warranty.
- Please note that there are no operator-serviceable parts inside the equipment. Any unauthorised interference with the product will invalidate the warranty.

### 1.4 Return policy

If the flowmeter has been diagnosed to be faulty, it can be returned to KATRONIC for repair using the Customer Returns Note (CRN) attached to the Appendix of this manual. KATRONIC regret that we cannot accept the return of the equipment unless accompanied by the completed CRN for Health & Safety reasons.

### 1.5 Legislative requirements

#### **CE marking**

The flowmeter is designed to meet the safety requirements in accordance with sound engineering practise. It has been tested and left the factory in a condition in which it is safe to operate. The equipment is in conformity with the statutory requirements of the EC directive and comply with applicable regulations and standards for electrical safety EN 61010 and electro-magnetic compatibility EN 61326. A CE Declaration of Conformity is issued in that respect, a copy of which can be found in the Appendix of these operating instructions.

#### **WEEE Directive**

The Waste Electrical and Electronic Equipment Directive (WEEE Directive) aims to minimise the impact of electrical and electronic goods on the environment, by increasing re-use and recycling and reducing the amount of WEEE going to landfill. It seeks to achieve this by making producers responsible for financing the collection, treatment, and recovery of waste electrical equipment, and by obliging distributors to allow consumers to return their waste equipment free of charge.



KATRONIC offers its customers the possibility of returning unused and obsolete equipment for correct disposal and recycling. The Dustbin Symbol indicates that when the last user wishes to discard this product, it must be sent to appropriate facilities for recovery and recycling. By not discarding this product along with other household-type waste, the volume of waste sent to incinerators or landfills will be reduced and natural resources will be conserved. Please use the Customer Return Note (CRN) in the Appendix for the return to KATRONIC.

#### **RoHS Directive**

The European Union's RoHS ("Restriction of the use of certain Hazardous Substances") Directive (2002/95/EC) goes into effect on July 1, 2006. All of the instrumentation manufactured by KATRONIC falls under Category 9, Measurement and Control Equipment. Currently this category is exempt from RoHS compliance until at least 2010, when it and other exemptions will be reviewed. Regardless of this, all products manufactured by KATRONIC are compliant with the RoHS Directive.

## 2 Introduction

### **Clamp-on transit-time flowmeter**

The KATflow 150 is an ultrasonic flowmeter utilising clamp-on sensors for the measurement of liquids in full closed pipes. Flow measurements can be undertaken without interrupting of the process or interfering with the integrity of the pipeline. The clamp-on sensors are simply attached to the outside of pipes. The KATflow 150 uses ultrasonic signals for the measurement of the flow, employing the so-called transit-time method.

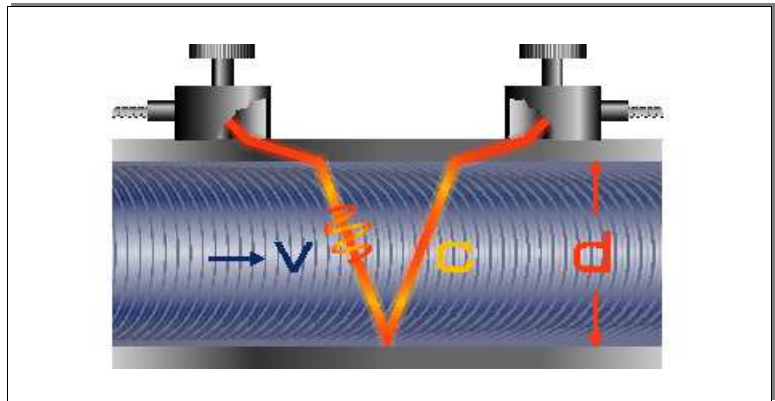


Illustration 1: Clamp-on ultrasonic flowmeter configuration

### **Measuring principle**

Ultrasonic signals are emitted by a first transducer installed on one side of a pipe, reflected on the opposite side and received by a second transducer. These signals are emitted alternatively in the direction of flow and against it. Because the medium in which the signals propagate is flowing, the transit time of the sound signals propagating in the direction of flow is shorter than the transit time of the signal propagating against the direction of flow. The transit-time difference  $\Delta T$  is measured and allows the determination of the average flow velocity along the path of acoustic propagation. A profile correction is then performed to obtain the average flow velocity over the cross-sectional area of the pipe, which is proportional to the volumetric flow rate.

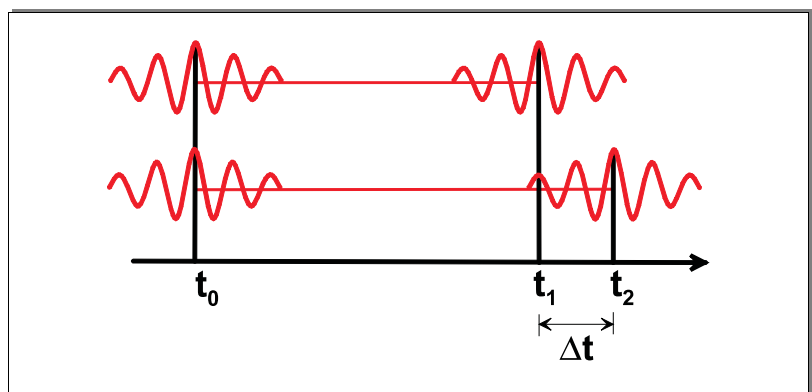


Illustration 2: Transit-time measuring principle

## 2 Installation

### 2.1 Unpacking and storage

#### 2.1.1 Unpacking

Care should be taken when opening the box containing the flowmeter, any markings or warnings shown on the parcel should be observed prior to opening. The following steps should then be taken:

- Unpack the flowmeter in a dry area.
- The flowmeter should be handled with care and not left in an area where it could be subject to physical shocks.
- If using a knife to remove packaging care should be taken not to damage the flowmeter or cables.
- When unpacking the sensor cables suitable lifting equipment should be used as long cables can be heavy.
- The flowmeter package and contents should be checked for completeness against the delivery note supplied and any missing items reported immediately.
- The flowmeter package and contents should be checked for signs of damage during transport and any problems reported immediately.
- The vendor accepts no responsibility for damage or injury caused during the unpacking of the instrumentation supplied.
- Excess packing materials should be either re-cycled or disposed of in a suitable way.

#### 2.1.2 Storage and preservation

If storage or preservation is necessary, the flowmeter and sensors should be stored:

- in a secure location,
- away from water and harsh environmental conditions,
- in a way as to avoid damage,
- small items should be kept together in the bags provided to avoid loss.

#### 2.1.3 Identification of components

The following items are typically supplied (please refer to your delivery note for a detailed description of your scope of supply):

- KATflow 150 flow transmitter
- Clamp-on sensors (one pair for single channel operation, two pairs for dual channel operation)
- Sensor connection cable(s) if not direct sensor connection
- Sensor mounting accessories
- Coupling component
- Operating instructions
- Project and/or hazardous area documentation (optional)
- Calibration certificate(s) (optional)



## 2.2 Clamp-on sensor installation

The correct selection of the sensor location is crucial for achieving reliable measurements and a high accuracy. Measurement must take place on a pipe in which sound can propagate (see Acoustic Propagation) and in which a rotationally symmetrical flow profile is fully developed (see Straight Pipe Lengths).

The correct positioning of the transducers is an essential condition for error-free measurements. It guarantees that the sound signal will be received under optimal conditions and evaluated correctly. Because of the variety of applications and the different factors influencing the measurement, there can be no standard solution for the positioning of the transducers.

The correct position of the transducers will be influenced by the following factors:

- diameter, material, lining, wall thickness and general condition of the pipe,
- the medium flowing in the pipe,
- and the presence of gas bubbles and solid particles in the medium.

Check that the temperature at the selected location is within the operating temperature range of the transducers (see Specification).

After the sensor location has been selected, make sure that that supplied cable is long enough to reach the flow transmitter mounting location. Ensure that the temperature at the selected location is within the ambient operating temperature range of the flow transmitter (see Specification).

**Acoustic propagation** Acoustic propagation is given when the flowmeter is able to receive sufficient signal from the transmitted ultrasonic pulses. The signals are attenuated in the pipe material, the medium and at each of the interfaces and reflections. External and internal pipe corrosion, solid particles and gas content in the medium do heavily contribute to signal attenuation.

**Straight pipe lengths** Sufficient straight lengths of pipe on the inlet and outlet of the measuring location guarantee an axi-symmetrical flow profile in the pipe for good measurement accuracy. If no sufficient straight lengths of pipe are available for your application, measurements are still obtainable but the uncertainty of the measurement can be compromised.

## 2.3 Installation location

Select an installation location as per recommendations in Table 1 and try to avoid measuring



- in the vicinity of deformations and defects of the pipe,
- near welding seams,
- where deposits could be building up in the pipe.

**For a horizontal pipe:**  
 Select a location where the transducers can be mounted on the side of the pipe, so that the sound waves emitted by the transducers propagate horizontally in the pipe. Thus, the solid particles deposited on the bottom of the pipe and the gas pockets developing at the top will not influence the propagation of the signal.

**Correct**

**Incorrect**

**For a free inlet or outlet pipe section:**  
 Select the measuring point at a location where the pipe cannot run empty.

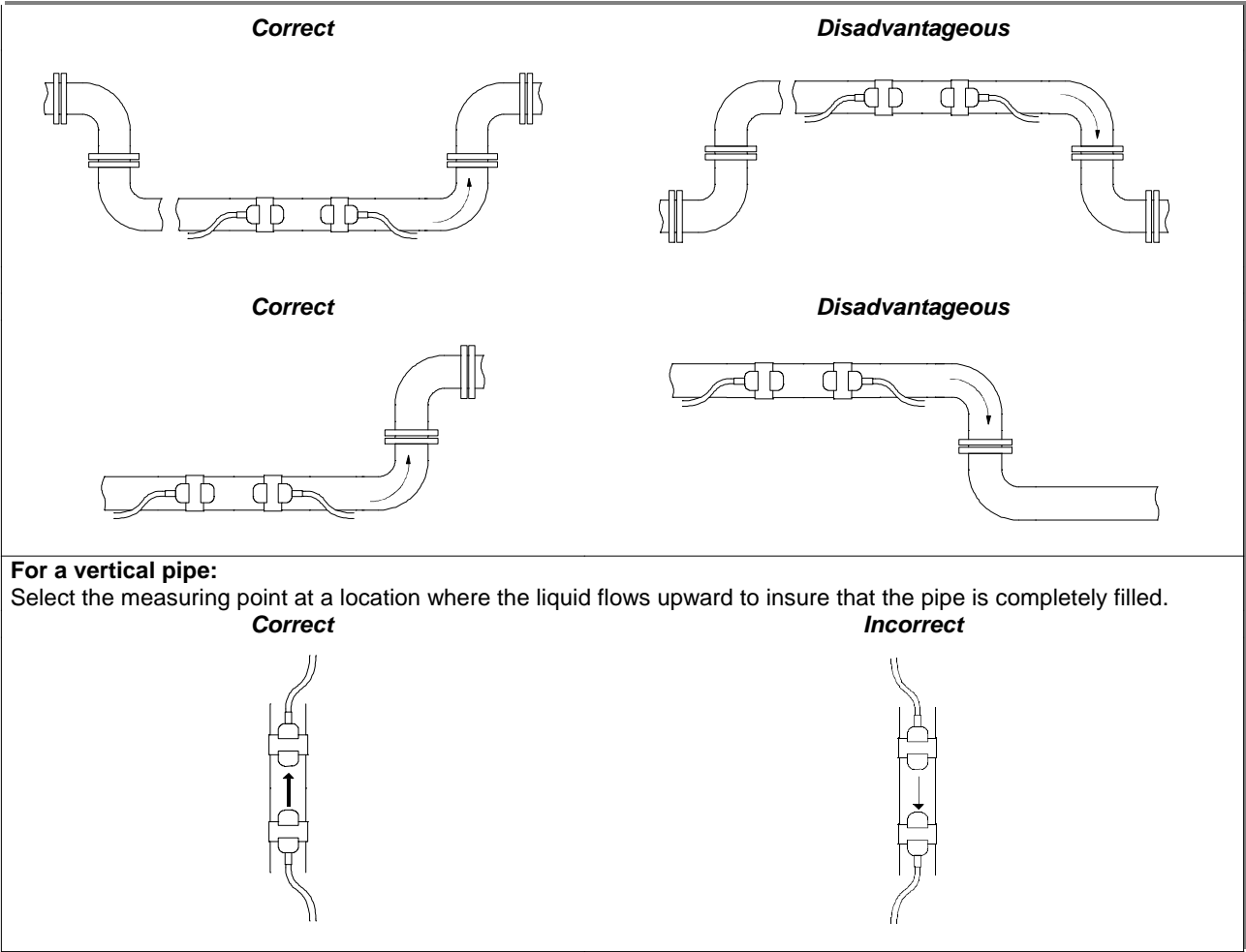
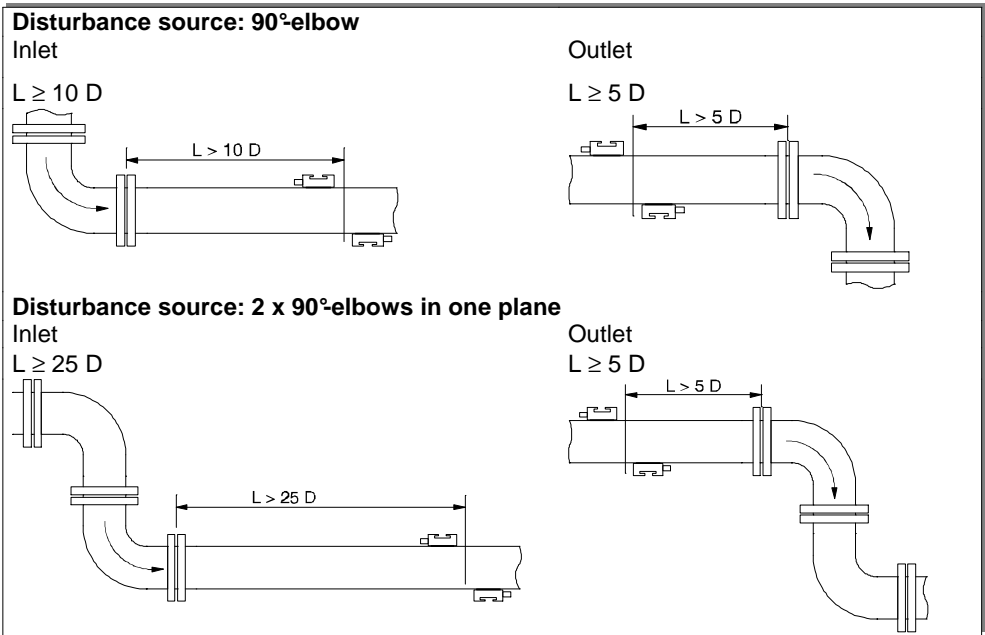


Table 1: Recommendations for sensor mounting location



Look for a sensor installation location with sufficient straight pipe to obtain accurate measurements. Please refer to Table 2 as a guideline for recommended distances to disturbance sources.



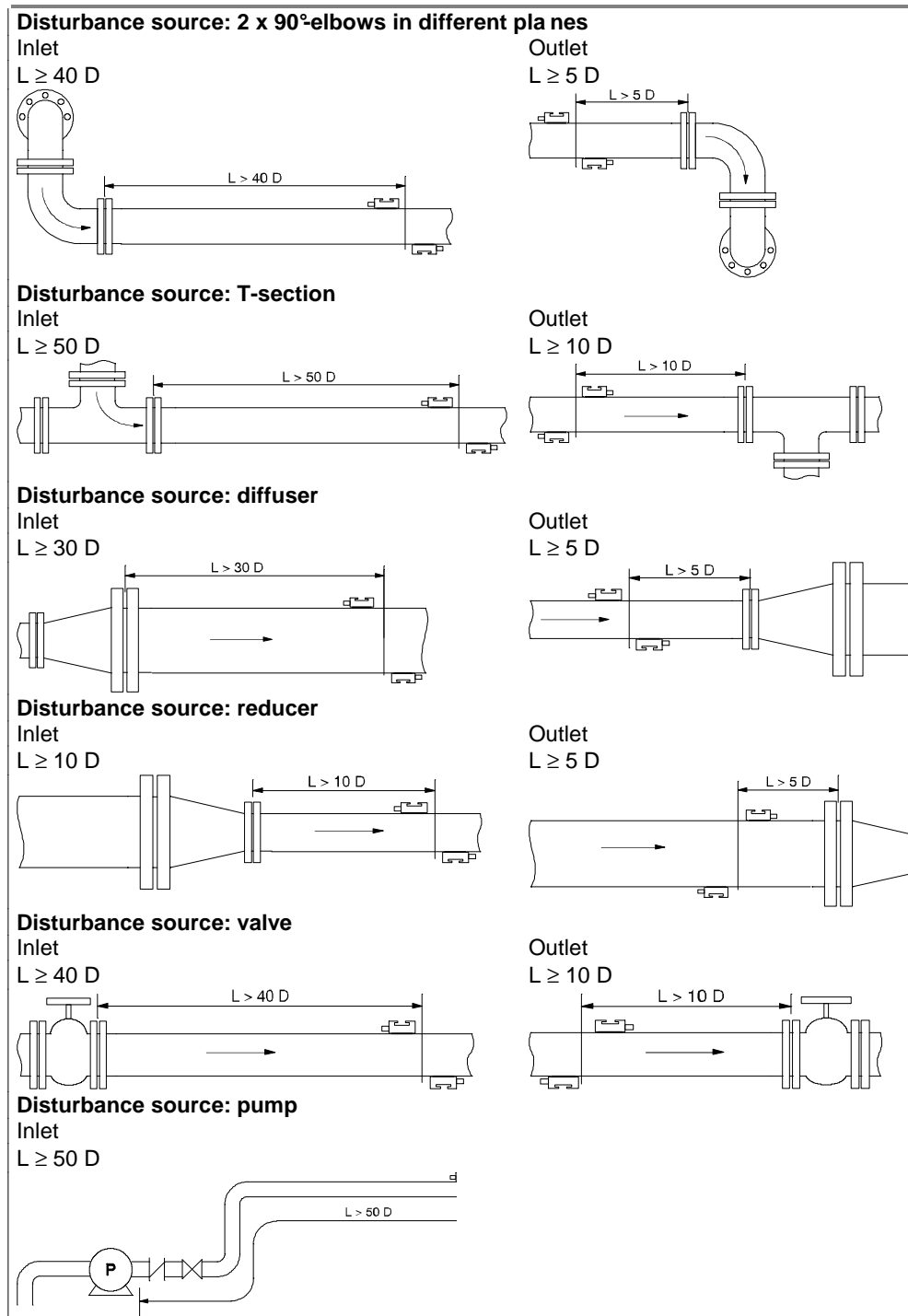


Table 2: Recommended distances from disturbance sources

## 2.4 Pipe preparation



- Clean the pipework from dirt and dust around the area where the sensors shall be placed.
- Remove loose paint and rust with a wire brush or file.

Firmly bonded paint does not necessarily need to be removed down to bare metal provided the flowmeter diagnostics indicate sufficient signal level strength.

## 2.5 Clamp-on sensor mounting configurations and sensor spacing

### Reflection Mode

The most common clamp-on sensor mounting configuration is the Reflection Mode, also known as V-Mode (see Illustration 3, sketch (1)). Here the ultrasonic signal pass twice through the medium (2 signal passes). The Reflection Mode is the most convenient mounting method as the sensor spacing distance can be measured easily and the sensors can be perfectly aligned. This method should be used whenever possible.

### Diagonal Mode

An alternative mounting configuration (Illustration 3, sketch (3)) is the Diagonal mode (Z-Mode = 1 signal pass). The signals travel here only once through the pipe. This method is often used especially for larger pipes where greater signal attenuation might occur.

Further variation of the Reflection and the Diagonal Mode are possible by altering the number of passes through the pipe. Any even number of passes would require to mount the sensors on the same side of the pipe, whereas with any odd number of passes, the sensors must be mounted on opposite sides of the pipe. Commonly for very small pipes, sensor mounting configurations such as 4 passes (W-mode) or 3 passes (N-mode) are used (Illustration 3, sketch (2)).

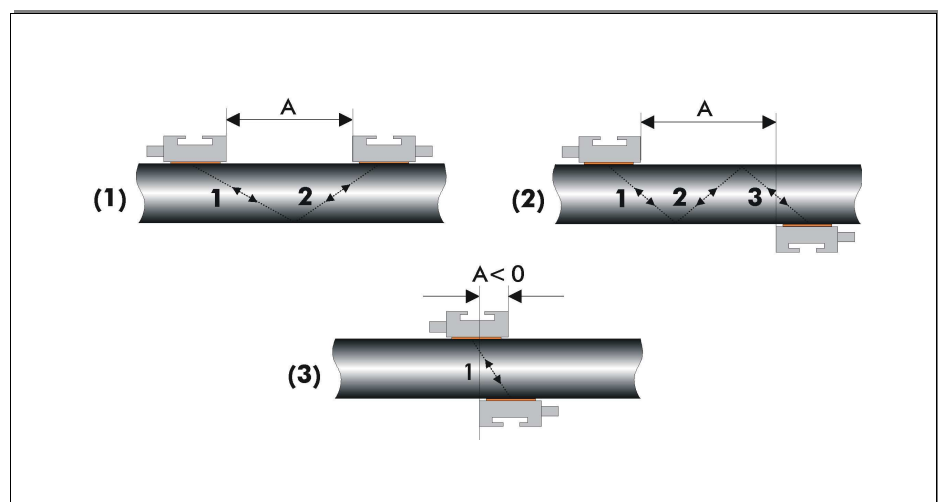


Illustration 3: Clamp-on sensor mounting configurations and sensor spacing

### Sensor spacing

The sensor spacing distance  $A$  is measured from the edges of the sensor heads facing each other as shown in illustration 3. It is automatically calculated by the flow-meter based on the parameter entries for pipe outside diameter, wall thickness, lining material and thickness, medium, process temperature, the sensor type and the selected number of signal passes.

A negative separation distance  $A < 0$  can occur for mounting configurations on small pipes where diagonal mode operation has been selected (see Illustration 3, sketch (3)).

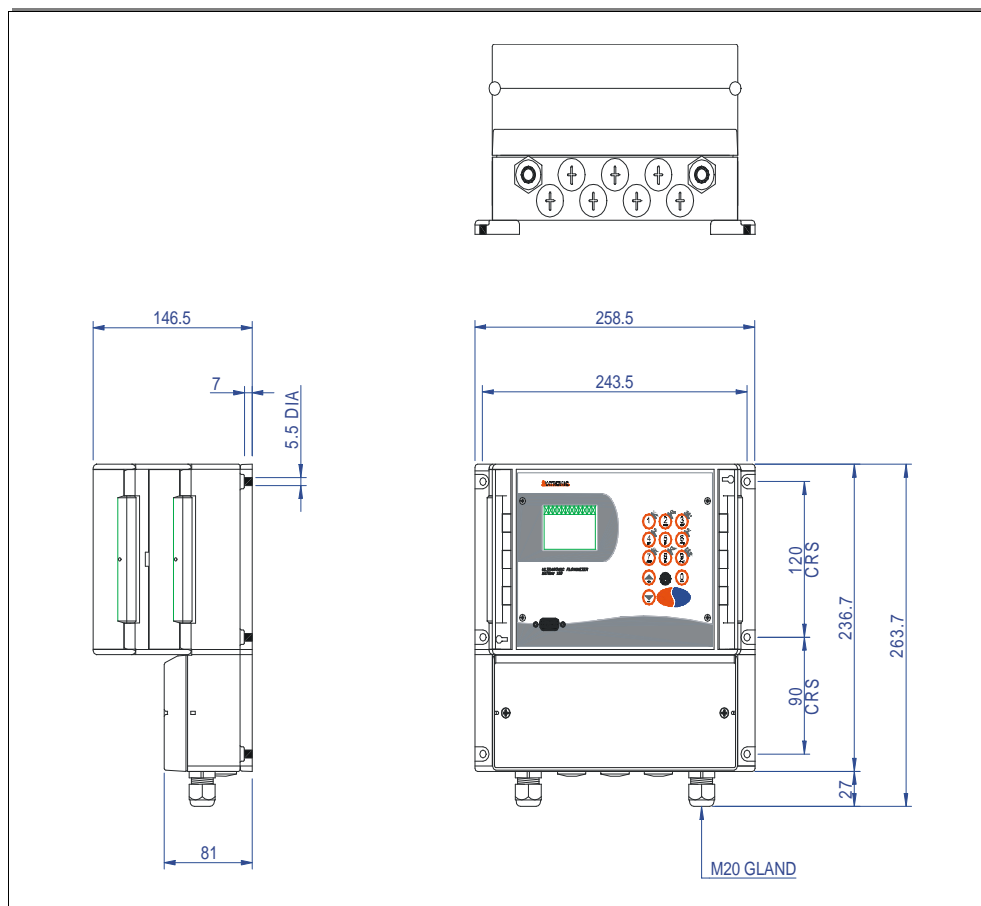


## 2.6 Transmitter installation

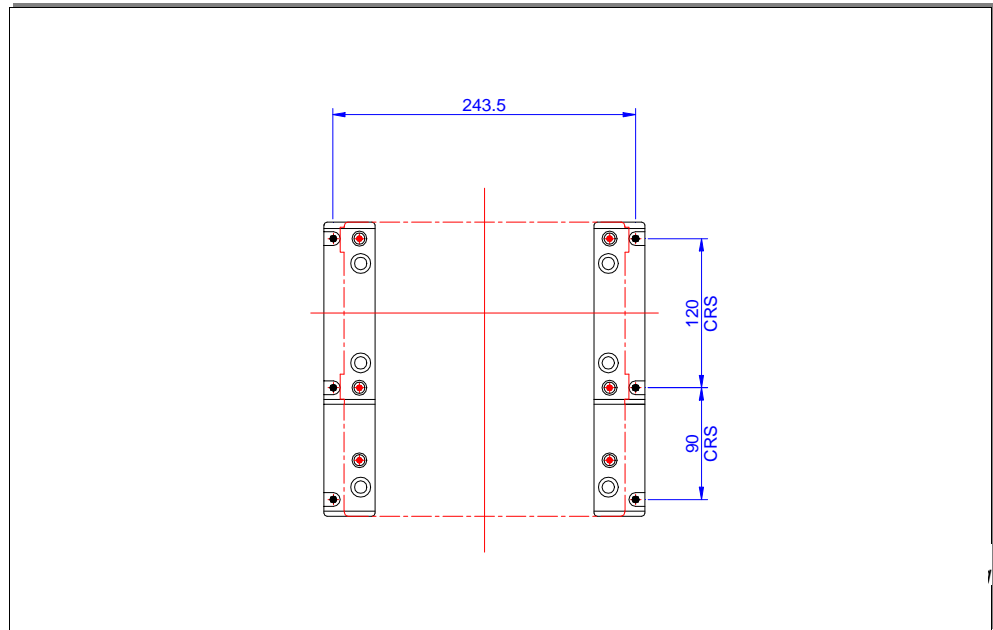
### 2.6.1 Wall mounting

The KATflow 150 is a wall mounted device and can be installed using 6 suitable screws and wall plugs according to the following drawings.

#### ***Transmitter outline dimensions***



Drawing 1: Outline dimensions KATflow 150 ultrasonic transmitter

**Drilling aid for wall mounting**

Make sure that the ambient temperature is within the -10 ... 60 °C operating temperature range specified for the transmitter unit.

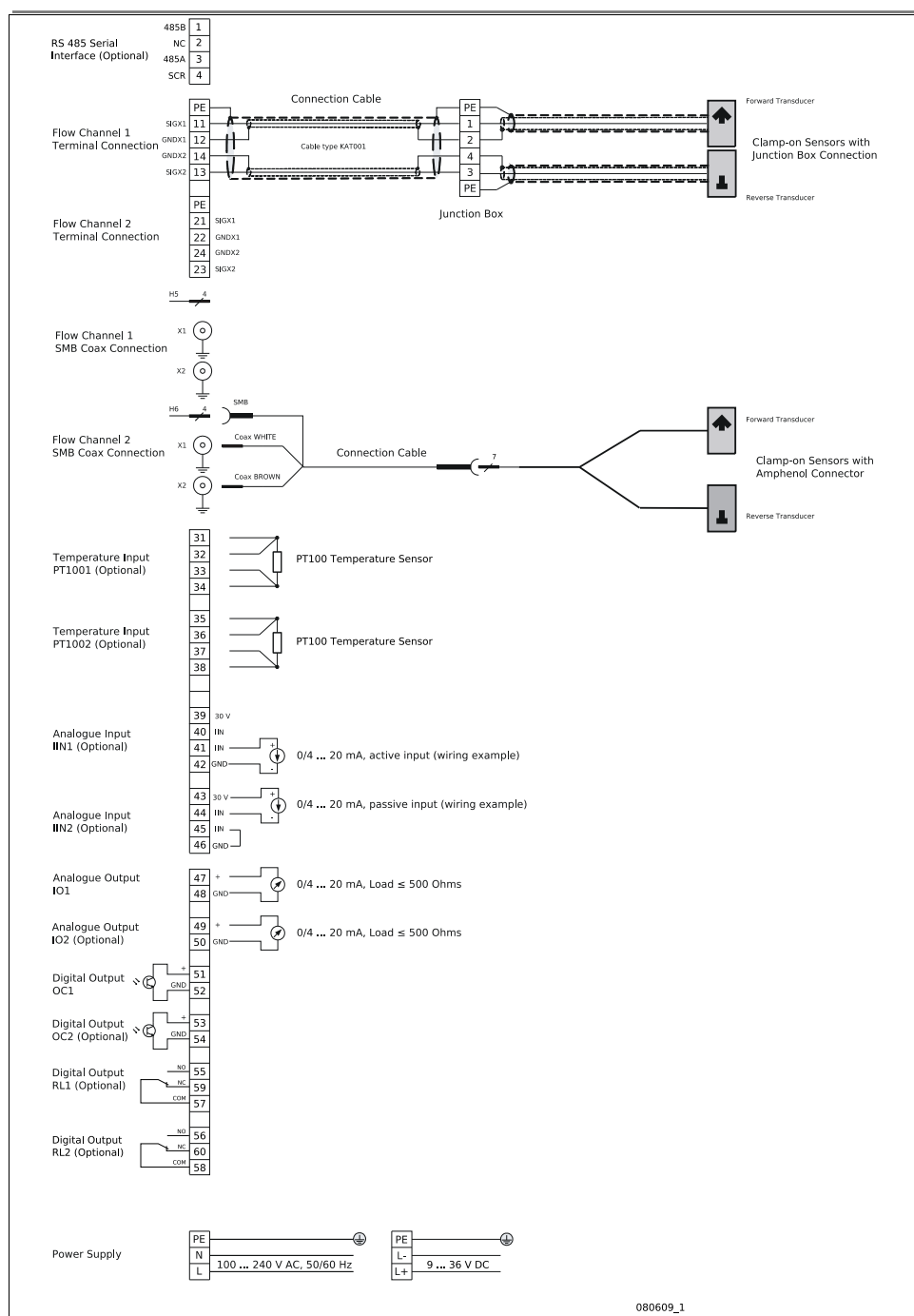
### 2.6.2 Electrical interconnections

Please note that in order to supply the unit with MAINS POWER, the equipment must be protected by suitably sized switches and circuit breakers.

#### Electrical wiring



100 ... 200 V AC, 50/60 Hz	10 W
9 ... 36 V DC	10 W



Drawing 3: Electrical interconnection diagram KATflow 150 transmitter

## 2.7 Clamp-on sensor mounting

### Sensor mounting

Before the sensors can be mounted

- the installation location should have been determined,
- a sensor mounting method should be chosen,
- the transmitter must be mechanically and electrically installed,
- the sensors must be connected to the transmitter.

Depending on which sensor mounting method is being used (V- or Z-Mode), the clamp on sensors are either mounted on the same side of the pipe (Reflection Mode) or on opposite sides of the pipe (Diagonal Mode). The sensor spacing is calculated by the flowmeter from the pipe parameters entered.

### 2.7.1 Sensor pipe mounting configurations

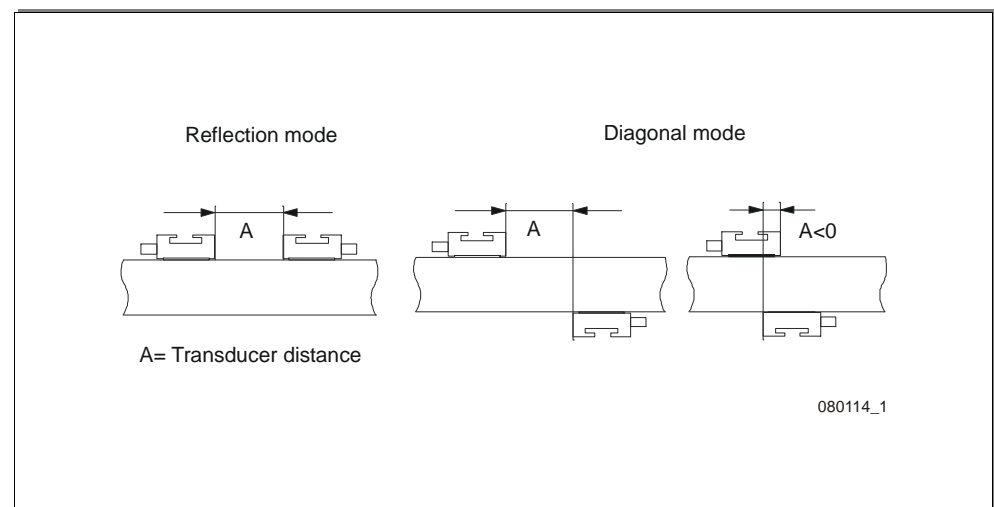


Illustration 4: Sensor pipe mounting configurations

### 2.7.2 Acoustic coupling gel



In order to obtain acoustical contact between the pipe and the sensors, apply a bead of acoustic coupling gel lengthwise down the centre of the contact area of the sensors.

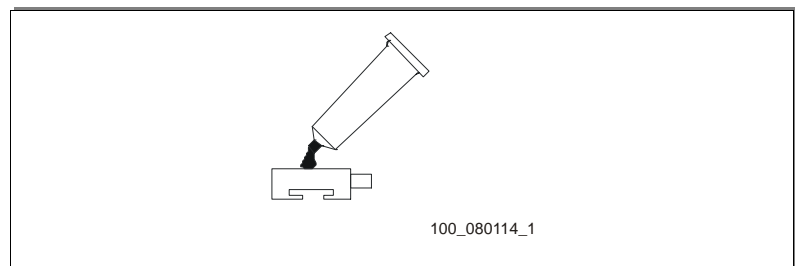


Illustration 5: Application of acoustic coupling gel



### 2.7.3 Correct positioning of the sensors

#### Correct sensor position

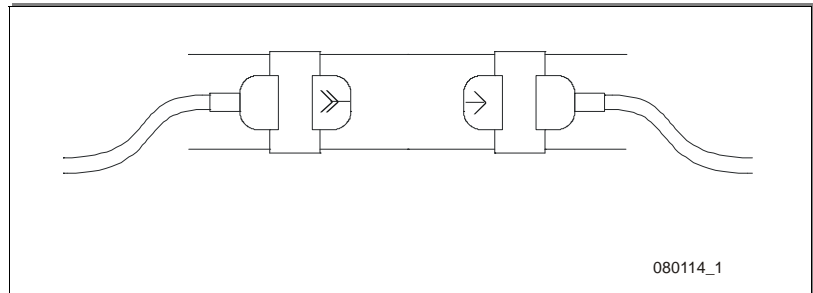


Illustration 6: Correct positioning of the sensors

Always mount the transducer pair such that the free front edges of the sensors face each other.

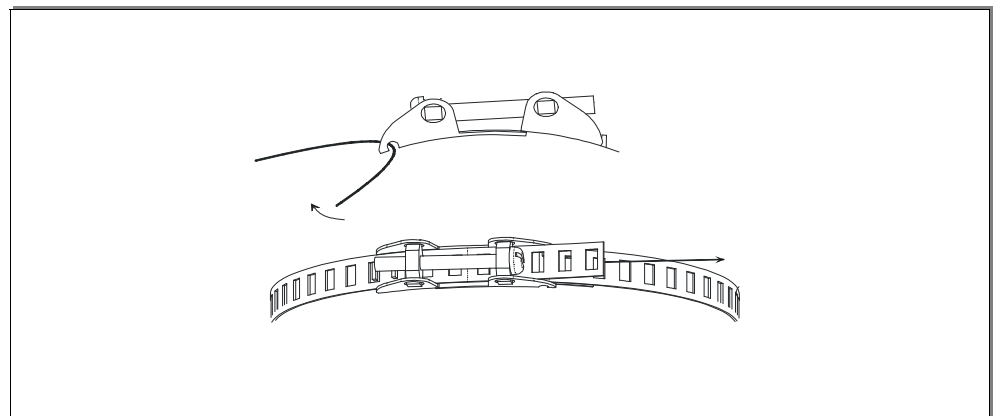


There is a different engraving on the top of each transducer. The transducers are mounted correctly if the engravings on the two transducers are forming an arrow together. The transducer cables should then show in opposite directions.

Later, the arrow, in conjunction with the indicated measured value, will help to determine the direction of flow.

The sensor spacing is automatically calculated by the flowmeter based on the parameter entries for pipe outside diameter, wall thickness, lining material and thickness, medium, process temperature, the sensor type and the selected number of signal passes (see chapter Operation).

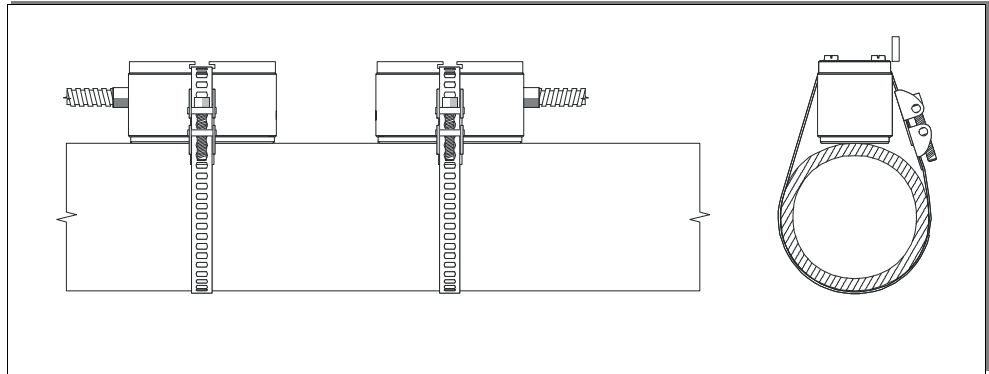
### 2.7.4 Sensor mounting with tension straps



Drawing 4: Metallic mounting straps

- Cut the tension straps to the appropriate length (circumference + 120 mm).
- Pull approximately 2 cm of the tension strap through the slot in the clamp and bend the strap back to secure the clamp to the tension strap.
- Guide the other end of the tension strap through the groove on top of the sensor.
- Place the sensor onto the prepared pipe section.
- Hold the clamp on the transducer with one hand and guide the tension strap around the pipe.

- Pull the tension strap and guide the free end through the clamp so that the clamp hooks engage. Slightly tighten the screw on the clamp.
- Mount the second sensor in the same way.
- Press the sensors firmly to the pipe. There should be no air pockets between the transducer surface and the pipe wall.
- Using a measuring tape, adjust the sensor separation distance as suggested by the flowmeter.



*Illustration 7: Sensor mounting with tension straps and clamps*

3 Operation

3.1 Switching On/Off

Switching On/Off

The flowmeter is switched on by applying the power supply to the instrument. Equally it can be switched off by disconnecting the external supply.

3.2 Keypad and display

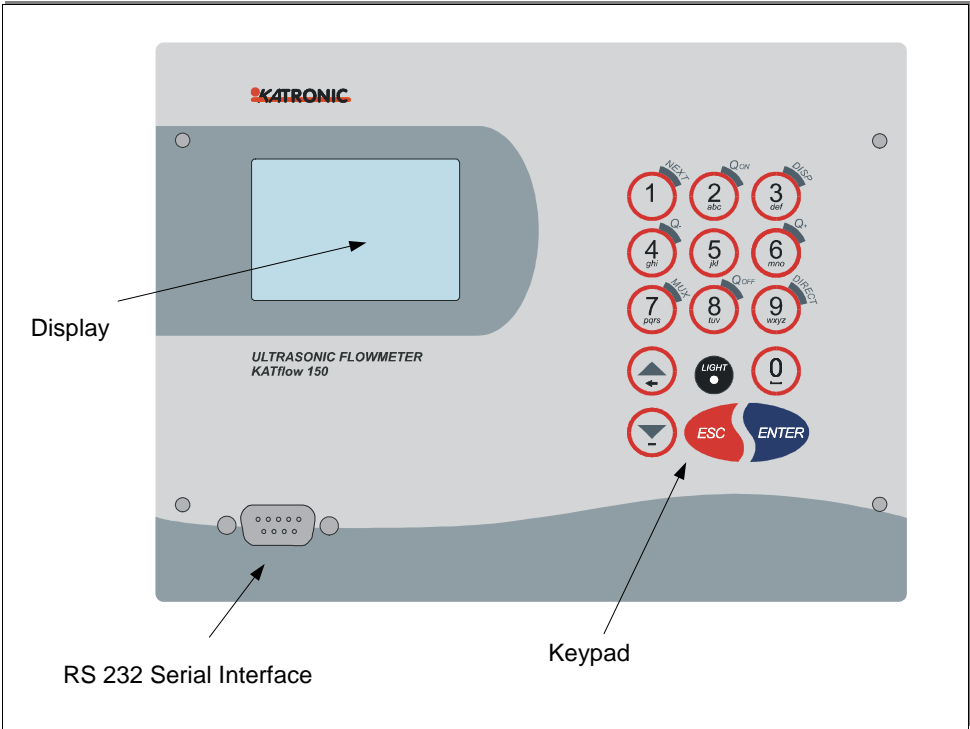





Illustration 8: Keypad and display overview

3.2.1 Keypad key functions

Keypad

Key	Main function	Secondary function
	Alphanumerical entry: 1 (1 short key stroke) , (2 short key strokes) . (3 short key strokes) _ (4 short key strokes)	Show <b>NEXT</b> available screen item within display category, i.e next measurement screen, next diagnostic screen
	Alphanumerical entry: A B C 2 /	<b>Q<sub>ON</sub></b> = Starts and resets totaliser function
	Alphanumerical entry: D E F 3 ?	Toggles to next <b>DIS</b> Play category, i.e. measurement displays, diagnostic displays










	Alphanumeric entry: G H I 4 <	<b>Q-</b> = Show negative total value
	Alphanumeric entry: J K L 5 >	
	Alphanumeric entry: M N O 6 \$	<b>Q+</b> = Show positive total value
	Alphanumeric entry: P Q R S 7	Toggle <b>MULTipleXer</b> (for multi-channel functionality)
	Alphanumeric entry: T U V 8 *	<b>QOFF</b> = Stop totaliser function, holds totaliser value until <b>QON</b> is pressed again
	Alphanumeric entry: W X Y Z 9	<b>DIRECT</b> access to password protected settings
	Move menu/list selection cursor or <b>UP</b>	Alphanumeric entry: Character backspace clear
	Numerical entry only: . (decimal point)	Switch LCD backlight on/off
	Alphanumeric entry: 0 <b>Space character</b> + = #	
	Move menu/list selection cursor or <b>DOWN</b>	Numerical entry only: - (minus sign)
	<b>ESC</b> ape menu item	Abort entry without saving

Table 3: Menu structure

	<b>ENTER</b> menu item	Confirm entry with saving
---	------------------------	---------------------------

### 3.2.2 Display functions

#### Main measurement display

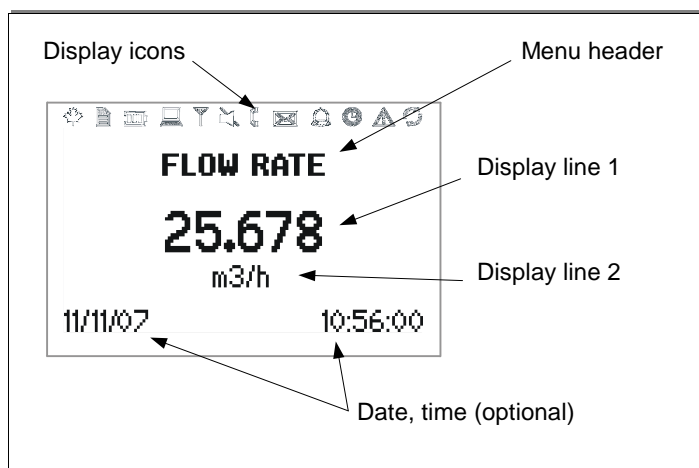










Illustration 9: Main measurement display

#### Display icons

Display icon	Function
	<b>On</b> Not used <b>Off</b>
	<b>On</b> Datalogger recording <b>Off</b> Datalogger switched off
	<b>On</b> Not used <b>Off</b>
	<b>On</b> Backlight switched on <b>Off</b> Backlight switched off
	<b>On</b> System I/O processor error <b>Off</b> I/O processor functioning correctly
	<b>On</b> Without strike-through: Speaker on <b>Off</b> With strike-through: Speaker off
	<b>On</b> Poor sensor coupling, low SNR <b>Off</b> Sensor coupling OK
	<b>On</b> Not used <b>Off</b>





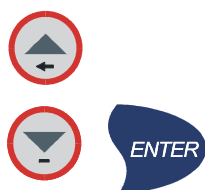
	<b>On</b> Not used <b>Off</b>
	<b>On</b> RTC operating <b>Off</b> RTC failure
	<b>On</b> Error recorded in error log <b>Off</b> No error detected
	<b>On</b> Serial communication on (RS232 and/or RS485) <b>Off</b> Serial communication off


Table 4: Display icons

### 3.3 Quick setup wizard

#### Quick start wizard

The quick setup wizard allows for a speedy setup of the most important parameters in order to achieve successful measurements in the shortest possible time:



Display screen	Operation
<b>MAIN MENU</b> <b>Quick start</b> System Installation Diagnostics Output Datalogger Input Serial Comm	Upon first power on and the boot-up sequence, the main menu is displayed.  Use <UP> and <DOWN> cursor keys to select <b>Quick start</b> . Confirm by pressing <ENTER>.
<b>QUICK START MENU</b> <b>Setup Wizard Single</b> Setup Wizard Dual Start Measurement	Use cursor keys to select <b>Setup Wizard</b> . Confirm by pressing <ENTER>.
<b>PIPE MATERIAL</b> 	Choose pipe material using cursor keys and pressing <ENTER>.
<b>OUTSIDE DIAMETER</b>  <b>76.1</b> mm	Enter outside pipe diameter using alphanumeric keys and confirm by pressing <ENTER>.  Use key <UP> as character backspace clear to correct for data entry errors.  If 0 is entered, an additional screen appears that allows entering the pipe circumference.



<p><b>WALL THICKNESS</b></p> <p><b>3.4</b> mm</p>	<p>Enter pipe wall thickness using alphanumerical keys and confirm by pressing <b>&lt;ENTER&gt;</b>.</p> <p>Use key <b>&lt;UP&gt;</b> as character backspace clear to correct for data entry errors.</p>						
<p><b>FLUID</b></p> <table border="1"> <tr><td>Water</td><td>▲</td></tr> <tr><td>Water</td><td>■</td></tr> <tr><td>Water</td><td>▼</td></tr> </table>	Water	▲	Water	■	Water	▼	<p>Select fluid using cursor keys.</p> <p>Confirm by pressing <b>&lt;ENTER&gt;</b>.</p>
Water	▲						
Water	■						
Water	▼						
<p><b>TEMPERATURE</b></p> <p><b>20.0</b> C</p>	<p>Enter process temperature using alphanumerical keys and confirm by pressing <b>&lt;ENTER&gt;</b>.</p> <p>Use key <b>&lt;UP&gt;</b> as character backspace clear to correct for data entry errors.</p>						
<p><b>LINER MATERIAL</b></p> <table border="1"> <tr><td>Rubber</td><td>▲</td></tr> <tr><td>Rubber</td><td>■</td></tr> <tr><td>Rubber</td><td>▼</td></tr> </table>	Rubber	▲	Rubber	■	Rubber	▼	<p>Select pipe lining material using cursor keys.</p> <p>Confirm by pressing <b>&lt;ENTER&gt;</b>.</p>
Rubber	▲						
Rubber	■						
Rubber	▼						
<p><b>PASSES</b></p> <table border="1"> <tr><td>Auto</td><td>▲</td></tr> <tr><td>Auto</td><td>■</td></tr> <tr><td>Auto</td><td>▼</td></tr> </table>	Auto	▲	Auto	■	Auto	▼	<p>Select transducer configuration (number of passes) using cursor keys.</p> <p><b>Auto</b> Automatically  <b>1</b> Z-mode (1 pass), diagonal mode  <b>2</b> V-mode (2 passes), reflection mode  <b>3</b> N-mode (3 passes), diagonal mode  <b>4</b> W-mode (4 passes), reflection mode  <b>5</b> 5 passes, diagonal mode  <b>6</b> 6 passes, reflection mode  <b>etc.</b></p> <p>Confirm by pressing <b>&lt;ENTER&gt;</b>.</p>
Auto	▲						
Auto	■						
Auto	▼						
<p><b>CHNL1 SENSOR</b></p> <p>Spacing 110.5 mm  Reflection 6 Mode  Signal 26 dB</p>	<p>Sensor placement screen: Mount transducers with suggested spacing. Observe signal strength.</p> <p>Confirm by pressing <b>&lt;ENTER&gt;</b> to obtain measurements.</p>						

Table 5: Quick setup wizard

<p><b>FLOW RATE</b></p> <p><b>25.678</b></p> <p>m3/h</p> <p>11/11/07 10:56:00</p>	Success!
---	----------

### 3.4 Measurements

#### 3.4.1 Main process value (PV) display

The measurements are started either through the Quick Setup Wizard or the menu structure by selecting **Start Measurement** upon first power on. Once all the parameters are programmed, any subsequent power-on sequences will bring up the main PV display immediately.

#### Measurement screens



Display screen	Operation
<p><b>FLOW RATE</b></p> <p><b>25.678</b></p> <p>m3/h</p> <p>11/11/07 10:56:00</p>	<p>The main process value can be changed by accessing the menu structure.</p> <p>Press <b>&lt;ESC&gt;</b> at any time to access the main menu.</p> <p>Change to other measurement screens by pressing <b>&lt;NEXT&gt;</b>.</p>

#### 3-line display format



Display screen	Operation
<p><b>FLOW</b></p> <p>Pump P3A</p> <p><b>25.678 m3/h</b></p> <p>1.370 m/s</p> <p>11/11/07 10:56:00</p>	<p>Line 1 shows the Tag ID but is universally configurable through the installation menu.</p> <p>Line 2 displays the main PV.</p> <p>Line 3 displays the flow velocity.</p> <p>Change to diagnostic displays by pressing <b>&lt;DISP&gt;</b>.</p>

#### 3.4.2 Diagnostic displays

#### Diagnostic screens



Display screen	Operation
<p><b>DIAGNOSTIC 1</b></p> <p>55.2 Gain</p> <p><b>20.5 Sig %</b></p> <p>5780.0 Correlation</p> <p>11/11/07 10:56:00</p>	<p>Line 1 shows the amplifier gain.</p> <p>Line 2 displays the signal strength.</p> <p>Line 3 indicates the correlation value.</p> <p>Change to more diagnostic screens by pressing <b>&lt;NEXT&gt;</b>.</p>



3.4.3 Totalisers

The totaliser displays will only be shown when the totalisers are activated.

**Totalisers**



Display screen	Operation
<p><b>TOTAL+</b></p> <p><b>2580.0</b></p> <p>m3</p> <p>11/11/07 10:56:00</p>	<p>The flow totaliser can be started by pressing <b>&lt;Q<sub>ON</sub>&gt;</b>. The grand total is displayed.</p> <p>Pressing <b>&lt;Q<sub>+</sub>&gt;</b> shows the total accumulated flow in positive flow direction.</p> <p>Pressing <b>&lt;Q<sub>-</sub>&gt;</b> shows the total accumulated flow in negative flow direction.</p> <p>The totalisers can be stopped by activating <b>&lt;Q<sub>OFF</sub>&gt;</b>.</p> <p>Change to other related display screens by pressing <b>&lt;NEXT&gt;</b>.</p>

## 4 Commissioning

### 4.1 Menu structure

#### Menu structure

Main menu	Menu level 1	Menu level 2	Description/settings
Quick Start			
	Setup Wizard Single		
		Units	<i>Select from list</i> ↑↓ m/s f/s in/s m3/h m3/min m3/s l/h l/min l/s USgall/h USgall/min USgall/s bbl/d bbl/h bbl/min g/s t/h kg/h kg/min
		Pipe material	<i>Select from list</i> ↑↓ Stainless steel Carbon steel Ductile cast iron Grey cast iron Copper Lead PVC PP PE ABS Glass Cement User (pipe c-speed)
		Pipe c-speed	<i>Only if user pipe material selected</i> 600 ... 6553.5 m/s
		Outside dia- meter	6 ... 6500 mm
		Wall thickness	0.5 ... 75 mm
		Fluid	<i>Select from list</i> ↑↓ Water Salt water Acetone Alcohol Ammonia Carbon Tet Ethanol Ethyl alcohol Ethyl ether Ethylene glycol Glycol/water 50% Kerosene Methanol Methyl alcohol Milk Naphtha Car oil Freon R134a

			Freon R22 Hydrochloric acid Sour cream Sulphuric acid Toluene Vinyl chloride User (kinematic viscosity, density, medium c-speed)
		Kinematic viscosity	<i>Only if user fluid selected</i> 0.001 ... 30000 mm <sup>2</sup> /s
		Density	<i>Only if user fluid selected</i> 100 ... 2000 kg/m <sup>3</sup>
		Medium c-speed	<i>Only if user fluid selected</i> 800 ... 3500 m/s
		Temperature	-30 ... 300 °C
		Liner Material	<i>Select from list</i> ↑↓ None Epoxy Rubber PVDF PP Glass User (liner c-speed)
		Liner c-speed	<i>Only if lining material selected</i> 600 ... 6553.0 m/s
		Liner thickness	<i>Only if lining material selected</i> 1.0 ... 99.0 mm
		Passes	<i>Select from list</i> ↑↓ Auto 1 2 3 4 5 6 etc.
		Sensor type	<i>Indication of sensor type and serial number if automatically detected, otherwise select from list</i> ↑↓ K1 K4 M Q Special
		Sensor frequency	<i>SP1, only for special, unrecognised sensors</i>
		Wedge angle	<i>SP2, only for special, unrecognised sensors</i>
		Wedge c-speed 1	<i>SP3, only for special, unrecognised sensors</i>
		Wedge c-speed 2	<i>SP4, only for special, unrecognised sensors</i>
		Crystal offset	<i>SP5, only for special, unrecognised sensors</i>
		Spacing offset	<i>SP6, only for special, unrecognised sensors</i>
		Zero flow offset	<i>SP7, only for special, unrecognised sensors</i>
		Upstream offset	<i>SP8, only for special, unrecognised sensors</i>
		Sensor placement	
	<b>Setup Wizard Dual</b>		
			<i>As per setup wizard single for channel 1</i>
			<i>Repeat for channel 2</i>

	<b>Start Measurement</b>		
		Sensor type	Indication of sensor type and serial number if automatically detected, otherwise select from list ↑↓ K1 K4 M Q Special
		SP 1 ... SP 8	Only for special, unrecognised sensors
		Sensor placement	
<b>Installation</b>			
	<b>Pipe</b>		
		Material	Select from pipe material list ↑↓
		Outside diameter	6 ... 6500 mm
		Wall thickness	0.5 ... 75 mm
		Pipe c-speed	600 ... 6553.5 m/s
		Pipe circumference	18.8 ... 20420.4 mm
		Roughness	0.0 ... 10 mm
	<b>Medium</b>		
		Fluid	Select from fluid list ↑↓
		Kinematic viscosity	0.001 ... 30000 mm <sup>2</sup> /s
		Density	100 ... 2000 kg/m <sup>3</sup>
		C-speed	800 ... 3500 m/s
		Temperature	-30 ... 300 °C
	<b>Lining</b>		
		Material	Select from material list ↑↓
		Thickness	1 ... 99 mm
		C-speed	600 ... 6553.0 m/s
	<b>Passes</b>		
		Passes	Select from list ↑↓
<b>Output</b>			
	<b>Display</b>		
		Units	Select from unit list ↑↓
		Damping	Smooths the display output, the higher the damping factor 1 ... 255 s
	<b>Current</b>		
		Mode	Yes – Current output on No – Current output off
		Min Value	Min. process variable (PV) value that corresponds to 0/4 mA
		Max Value	Max. process variable (PV) value that corresponds to 20 mA
		Damping	Additional smoothing of the current output, the higher the damping factor 1 ... 255 s
	<b>Open Collector</b>		

		Mode	Yes – Pulse output on No – Pulse output off
		Pulse Value	Totaliser value of selected PV at which a pulse is generated, e.g. PV = [m3/h], Pulse Value = 10, a pulse is output every 10 m3 0.01 ... 1000
		Pulse Width	Width of the pulse 30 ... 999 ms
		Calc. Max	This is the calculated max. number of pulses per second., i.e. the max. pulse rate in Hz
	<b>Relay</b>		
		Mode	Off – Permanently off On – Permanently energised Alarm – PV alarm switch Fault – Allocated to system failures, see error report list
		On Point	Value of PV at which the relay energises when in alarm mode
		Off Point	Value of PV at which the relay de-energises when in alarm mode
<b>Input</b>			
	<b>Current</b>		
		Current IP Log	Yes – If serial output is turned on, mode printer, then the current input value is output via serial communication No
	<b>Temperature</b>		
		Source	Fixed – A fixed temperature can be entered under value PT100 – Value read from PT100 temperature sensor in °C
		Value	Enter fixed user defined value 0 ... 250 °C
<b>System</b>			
	<b>Instrument info</b>		
		Model Code	150
		Serial No.	Example: 90000003
		HW Revision	Example: 1.0, 1.0
		SW Revision	Example: 1.0, 1.0
	<b>Calculation</b>		
		Low F Cut	± Low flow velocity cut off 0 ... 0.25 m/s
		Max F Cut	± Maximum flow velocity cut off 0 ... 30 m/s
		Corrected	Apply flow velocity profile correction Yes No
		PV Offset	Calibration process variable zero offset -30 ... 30 units
		PV Scaling	Calibration process variable gradient scaling 0 ... 10000 units
	<b>Zero Cal</b>		<b>Zero calibration settings</b>
		Zero	Perform auto zero calibration Yes No
		Track	Track zero offset

			Yes No
		Delta	Zero flow delta time offset in ns, read from sensor PROM or entered directly for special sensors
		Timeup	Upstream transit-time offset in $\mu$ s, allows for fixed delays in special sensors, buffer rods and extension leads
	<b>User</b>		
		Identifier	Example: Pump P3A 9 alphanumeric character string
		Tag No.	Example: 1FT-3011 9 alphanumeric character string
	<b>Test</b>		
		Test Mode	Control system simulation: 60 second ramping up of flow velocity in m/s from 0 to programmed Max F Cut and subsequent 60 second ramping down, i.e. the process variable would change over complete possible range. All configured outputs will exhibit their programmed behaviour. Yes No
	<b>Settings</b>		
		Date	Example: 03/10/07
		Time	Example: 09:27:00
		Date Format	Select from list $\uparrow\downarrow$ dd/mm/yy mm/dd/yy yy/mm/dd
		Language	Select from list $\uparrow\downarrow$ English German French Spanish Russian
		Keypad	Enable keypad sound Yes No
	<b>Defaults</b>		Reload factory default settings, except for date and time Yes No
<b>Diagnostics</b>			
		Temperature	Shows control unit temperature
		Log Memory	Percentage of unused datalogger memory remaining
<b>Datalogger</b>			
		Interval	A value of zero turns the datalogger off, a non-zero value turns the datalogger on and defines the logging interval. Going from a value of zero to a non-zero value, clears the log memory. 0 ... 999 s
		Overwrite	When the log memory is full, i.e. 0 % remaining, the logger wraps around and starts to overwrite memory. Yes No
		Low Memory	Warning output: The amount of memory remaining at which the flowmeter begins to give an audible warning. 0 ... 100 %
		Log Download	Sends logger content to selected serial commu-

			nication port.
<b>Serial Comm</b>			
		Mode	Select from list ↑↓ None Printer Diagnostic Log download
		Baud	Select from list ↑↓ 2400 9600 (Default) 19200
		Parity	Select from list ↑↓ None Even (Default) Odd
		Type	Select from list ↑↓ Selects the active serial communication port None RS232 RS485

Table 6: Firmware menu structure

## 4.2 Diagnostics

Diagnostic screens can be accessed directly during measurement or through the menu structure.

## 4.3 Display settings

The main Process Value (PV) is the primary measurement data. Customer specific settings for data to be displayed can be achieved by accessing the appropriate menu items. The PV can be selected from a list of available items.

## 4.4 Output configurations

### 4.4.1 Serial interface RS 232

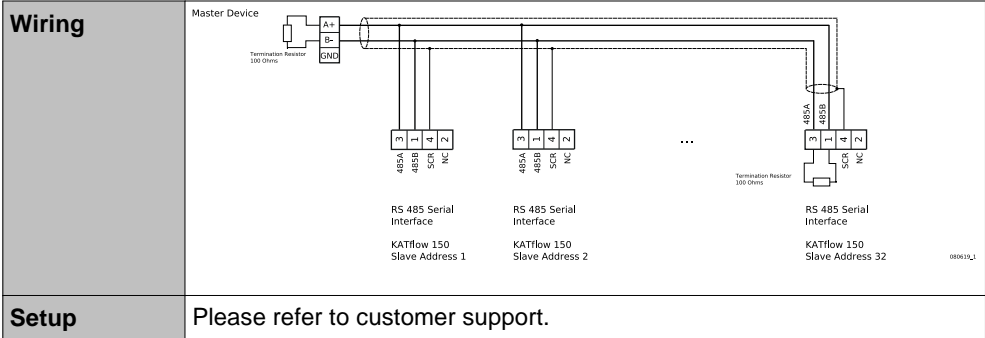
The RS 232 serial interface can be used to transmit data on-line or to download the integral datalogger content. The settings can be found in submenu **Serial Comm**.

### 4.4.2 Serial interface RS 485

The RS 485 interface is used for networking up to 32 flowmeters to a centralised computer system. Each flowmeter is given an unique address to be able to communicate effectively. The communication protocol used conforms to the conventions of the Modbus RTU protocol, a description of which is given in a separate document. Please refer to customer support for further information.

In addition, the ASCII printer output can be redirected through the RS 485 interface rather than the RS 232 to increase the transmission distance.

### Serial interfaces



<b>Operation</b>	Please refer to customer support.
------------------	-----------------------------------

### Analogue outputs



#### 4.4.3 Analogue current output 0/4 ... 20 mA

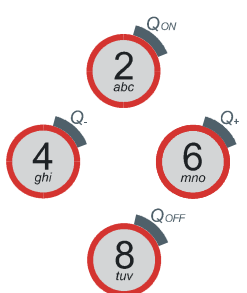
The analogue current outputs operate in 4 ... 20 mA mode by default. 0 ... 20 mA operation is possible, please contact customer support.

Current output 1 is assigned to the PV of channel 1, output 2 is assigned to the PV of channel 2 (on a two-channel system).

The current outputs can be programmed and scaled within the menu structure.

<b>Wiring</b>	<p>Analogue Output IO1</p> <p>Analogue Output IO2 (Optional)</p> <p>0/4 ... 20 mA, Load ≤ 500 Ohms</p> <p>0/4 ... 20 mA, Load ≤ 500 Ohms</p> <p>080619_1</p>
<b>Electrical characteristics</b>	<p>Range = 0/4 ... 20 mA</p> <p>Resolution = 16 bit</p> <p>U = 30 V</p> <p><math>R_{Load} &lt; 500 \Omega</math></p> <p>Accuracy = 0.1 %</p> <p>Galvanically isolated from main device and other I/O</p>

### Digital outputs



#### 4.4.4 Digital Open-Collector output

Open-Collector output 1 is assigned to the totaliser function of channel 1 which is related to the selected PV. Open-Collector output 2 is assigned in the same way to channel 2 (on a two-channel system).

The totaliser function is enabled and controlled using the **<Q<sub>ON</sub>>**, **<Q<sub>+</sub>>**, **<Q<sub>-</sub>>** and **<Q<sub>OFF</sub>>** keys and from the menu structure where the pulse value and width are selected.

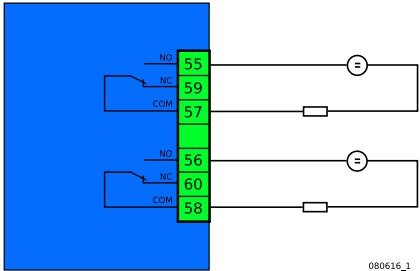
<b>Wiring</b>	<p>Digital Output OC1</p> <p>Digital Output OC2 (Optional)</p> <p>080619_1</p>
<b>Electrical characteristics</b>	<p>U = 24 V</p> <p><math>I_{max} = 4 \text{ mA}</math></p> <p>Value = 0.01 ... 1000</p> <p>Pulse width = 30 ... 999 ms</p>

#### 4.4.5 Digital relay output

Relay output 1 is assigned to the PV value of channel 1. Relay output 2 is assigned in the same way to channel 2 (on a two-channel system).

The relay outputs are enabled and controlled using the menu structure.

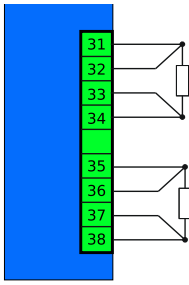


Wiring	<div><div>Digital Output RL1 (Optional)</div><div>Digital Output RL2 (Optional)</div><div>080616_1</div></div>
Electrical characteristics	Form C (SPDT-CO) contacts V = 48 V I <sub>max</sub> = 250 mA

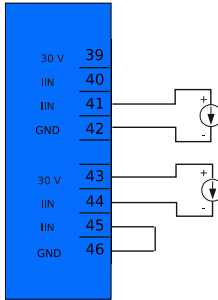
4.5 Input configurations

4.5.1 PT100 inputs

Inputs

Wiring	<div><div>Temperature Input PT1001 (Optional)</div><div>Temperature Input PT1002 (Optional)</div><div>080619_1</div></div>
Electrical characteristics	PT100 4-wire circuit Measuring range = -50 ... 400 °C Resolution = 0.1 K Accuracy = ±0.2 K

4.5.2 Analogue current input 0/4 ... 20 mA

Wiring	<div><div>Analogue Input IIN1 (Optional)</div><div>Analogue Input IIN2 (Optional)</div><div>080619_1</div></div>
Electrical characteristics	Active or passive wiring Measuring range active = 0 ... 20 mA at 30 V Measuring range passive = 4 ... 20 mA Accuracy = 0.1 % of measured value

4.6 Heat quantity measurement (HQM)

Future implementation.

4.7 Sound velocity measurement (SVM)

Future implementation.

## **4.8 Dual-channel flow calculations (maths functions)**

Future implementation

## **5 Maintenance**

No general maintenance is required for this equipment.

## 6 Troubleshooting

Should there be the need to call customer service, please let us know the following details:



- Model code
- Serial number
- SW, HW revision
- Error log list

Possible error messages may include the following:

### Error list

Error message	Group	Description	Error handling
USB INIT FAIL	Hardware	Internal board communication error	Power on/off, otherwise call customer support
NO SERIAL NO.	Hardware	Failed to read from FRAM	Call customer support
NO VERSION NO.	Hardware	Failed to read from FRAM	Call customer support
PARA READ FAIL	Hardware	Failed to read from FRAM	Load defaults, otherwise call customer support
PARA WRITE FAIL	Hardware	Failed to write to FRAM	Load defaults, otherwise call customer support
VAR READ FAIL	Hardware	Failed to read from FRAM	Call customer support
VAR WRITE FAIL	Hardware	Failed to write to FRAM	Call customer support
SYSTEM ERROR	Hardware		Call customer support
VISIBILITY ERR	Hardware	Failed to read from FRAM	Call customer support
FRAM LONG WRITE ERR	Hardware	Failed to write to FRAM	Call customer support
FRAM READ ERR	Hardware	Failed to read from FRAM	Call customer support
RTC ERR	Hardware	Real Time Clock failure	Power on/off, otherwise call customer support
EXTMEM ERR	Hardware	Logger memory failure	Power on/off, otherwise call customer support
SPI ERR	Hardware	SPI bus failure	Power on/off, otherwise call customer support
I2C ERR	Hardware	I2C bus failure	Power on/off, otherwise call customer support
MATH ERR	Software	Internal calculation error	Call customer support
STACK ERR	Software	Internal calculation error	Call customer support
ADDR ERR	Software	Internal calculation error	Call customer support
OSC ERR	Software	Internal calculation error	Call customer support
ADC ERR	Software	Internal calculation error	Call customer support
IO ERR	Software	Internal calculation error	Call customer support
TIMING ERR	Software	Internal calculation error	Call customer support
COMM INIT ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM START ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM HS0 ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support

COMM HS1 ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM READ AVE ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM READ RAW ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM READ HISTORY ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
COMM CRC ERR	Hardware	Internal communication error	Power on/off, otherwise call customer support
SENSOR COUPLING ERR	Application	Weak sensor coupling, low SNR	Recouple sensors, check installation, reduce number of passes, look for other location, then have a cup of tea and call customer support!

Table 7: Error messages

## 7 Technical data

Material	Sound Speed* Shear Wave (at 25 °C)	
	m/s	ft/s
Steel, 1% Carbon, hardened	3,150	10,335
Carbon Steel	3,230	10,598
Mild Steel	3,235	10,614
Steel, 1% Carbon	3,220	10,565
302 Stainless Steel	3,120	10,236
303 Stainless Steel	3,120	10,236
304 Stainless Steel	3,141	10,306
304L Stainless Steel	3,070	10,073
316 Stainless Steel	3,272	10,735
347 Stainless Steel	3,095	10,512
Aluminium	3,100	10,171
Aluminium (rolled)	3,040	9,974
Copper	2,260	7,415
Copper (annealed)	2,325	7,628
Copper (rolled)	2,270	7,448
CuNi (70%Cu 30%Ni)	2,540	8,334
CuNi (90%Cu 10%Ni)	2,060	6,759
Brass (Naval)	2,120	6,923
Gold (hard-drawn)	1,200	3,937
Inconel	3,020	9,909
Iron (electrolytic)	3,240	10,630
Iron (Armco)	3,240	10,630
Ductile Iron	3,000	9,843
Cast Iron	2,500	8,203
Monel	2,720	8,924
Nickel	2,960	9,712
Tin (rolled)	1,670	5,479
Titanium	3,125	10,253
Tungsten (annealed)	2,890	9,482
Tungsten (drawn)	2,640	8,661
Tungsten (carbide)	3,980	13,058
Zinc (rolled)	2,440	8,005
Glass (pyrex)	3,280	10,761
Glass (heavy silicate first)	2,380	7,808
Glass (light brate crown)	2,840	9,318
Nylon	1,150	3,772
Nylon, 6-6	1,070	3,510
Polyethylene (LD)	540	1,772
PVC, CPVC	1,060	3,477
Acrylic	1,430	4,690

\* Please note these values are to be considered nominal. Solids may be inhomogeneous and anisotropic. Actual values depend on exact composition, temperature, and to a lesser extent, on pressure and stress.

All data given at 25 °C (77 °F) unless otherwise stated

Substance	Chemical Formula	Specific Gravity	Sound Speed		Change	Kinematic	Viscosity
			m/s	ft/s	v/°C	x10 <sup>-6</sup>	ft <sup>2</sup> /s
Acetic anhydride	(CH <sub>3</sub> CO) <sub>2</sub> O	1.082 (20 °C)	1,180	3,871.4	2.5	0.769	8.274
Acetic acid, anhydride	(CH <sub>3</sub> CO) <sub>2</sub> O	1.082 (20 °C)	1,180	3,871.4	2.5	0.769	8.274
Acetic acid, nitrile	C <sub>2</sub> H <sub>3</sub> N	0.783	1,290	4,232.3	4.1	0.441	4.745
Acetic acid, ethyl ester	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	0.901	1,085	3,559.7	4.4	0.467	5.025
Acetic acid, methyl ester	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	0.934	1,211	3,973.1		0.407	4.379
Acetone	C <sub>3</sub> H <sub>6</sub> O	0.791	1,174	3,851.7	4.5	0.399	4.293
Acetylene dichloride	C <sub>2</sub> H <sub>2</sub> Cl <sub>2</sub>	1.26	1,015	3,330.1	3.8	0.400	4.304
Alcohol	C <sub>2</sub> H <sub>6</sub> O	0.789	1,207	3,960	4.0	1.396	15.02
Ammonia	NH <sub>3</sub>	0.771	1,729 (-33 °C)	5,672.6 (-27 °C)	6.68	0.292 (-33 °C)	3.141 (-27 °F)
Benzene	C <sub>6</sub> H <sub>6</sub>	0.879	1,306	4,284.8	4.65	0.711	7.65
Benzol	C <sub>6</sub> H <sub>6</sub>	0.879	1,306	4,284.8	4.65	0.711	7.65
Bromine	Br <sub>2</sub>	2.928	889	2,916.7	3.0	0.323	3.475
n-Butane(2)	C <sub>4</sub> H <sub>10</sub>	0.601 (0°C)	1,085 (-5° C)	3,559.7 (23 °C)	5.8		
2-Butanol	C <sub>4</sub> H <sub>10</sub> O	0.81	1,240	4,068.2	3.3	3.239	34.851
sec-Butylalcohol	C <sub>4</sub> H <sub>10</sub> O	0.81	1,240	4,068.2	3.3	3.239	34.851
n-Butyl bromide (46)	C <sub>4</sub> H <sub>9</sub> Br	1.276 (20°C)	1,019 (20°C)	3,343.2 (68°F)		0.49 (15°C)	5.272 (59°C)
n-Butyl chloride (22,46)	C <sub>4</sub> H <sub>9</sub> Cl	0.887	1,140	3,740.2	4.57	0.529 (15°C)	5.692 (59°F)
Carbon tetrachloride	CCl <sub>4</sub>	1.595 (20°C)	926	3,038.1	2.48	0.607	6.531
Carbon tetrafluoride (Freon 14)	CF <sub>4</sub>	1.75 (-150 °C)	875.2 (-150 °C)	2,871.5 (-238 °F)	6.61		
Chloroform	CHCl <sub>3</sub>	1.489	979	3,211.9	3.4	0.55	5.918
Dichlorodifluoromethane (Freon 12)	CCl <sub>2</sub> F <sub>2</sub>	1.516 (40 °C)	774.1	2,539.7	4.24		
Ethanol	C <sub>2</sub> H <sub>6</sub> O	0.789	1,207	3,960	4.0	1.39	14.956
Ethyl acetate	C <sub>4</sub> H <sub>8</sub> O <sub>2</sub>	0.901	1,085	3,559.7	4.4	0.489	5.263
Ethyl alcohol	C <sub>2</sub> H <sub>6</sub> O	0.789	1,207	3,960	4.0	1.396	15.020
Ethyl benzene	C <sub>8</sub> H <sub>10</sub>	0.867 (20 °C)	1,338 (20 °C)	4,289.8 (68 °F)		0.797 (17 °C)	8.575 (63 °F)
Ether	C <sub>4</sub> H <sub>10</sub> O	0.713	985	3,231.6	4.87	0.311	3.346
Ethyl ether	C <sub>4</sub> H <sub>10</sub> O	0.713	985	3,231.6	4.87	0.311	3.346
Ethylene bromide	C <sub>2</sub> H <sub>4</sub> Br <sub>2</sub>	2.18	995	3,264.4		0.79	8.5
Ethylene chloride	C <sub>2</sub> H <sub>4</sub> Cl <sub>2</sub>	1.253	1,193	3,914		0.61	6.563
Ethylene glycol	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	1.113	1,658	5,439.6	2.1	17,208 (20°C)	185.158 (68°F)
Fluorine	F	0.545 (-143 °C)	403 (-143 °C)	1,322.2 (-225 °F)	11.31		
Formaldehyde, methyl ester	C <sub>2</sub> H <sub>4</sub> O <sub>2</sub>	0.974	1,127	3,697.5	4.02		
Freon R12			774.2	2,540			
Glycol	C <sub>2</sub> H <sub>6</sub> O <sub>2</sub>	1.113	1,658	5,439.6	2.1		
50% Glycol/50% H <sub>2</sub> O			1,578	5,177			
Isopropanol	C <sub>3</sub> H <sub>8</sub> O	0.785 (20 °C)	1,170 (20 °C)	3,838.6 (68 °F)		2.718	29.245
Isopropyl alcohol (46)	C <sub>3</sub> H <sub>8</sub> O	0.785 (20 °C)	1,170 (20 °C)	3,838.6 (68 °F)		2.718	29.245
Kerosene		0.81	1,324	4,343.8	3.6		

Methane	CH <sub>4</sub>	0.162 (-89 °C)	405 (-89 °C)	1,328.7 (-128 °F)	17.5		
Methanol	CH <sub>4</sub> O	0.791 (20 °C)	1,076	3,530.2	292	0.695	7.478
Methyl acetate	C <sub>3</sub> H <sub>6</sub> O <sub>2</sub>	0.934	1,211	3,973.1		0.407	4.379
Methyl alcohol	CH <sub>4</sub> O	0.791	1,076	3,530.2	292	0.695	7.478
Methyl benzene	C <sub>7</sub> H <sub>8</sub>	0.867	1,328 (20 °C)	4,357 (68 °F)	4.27	0.644	7.144
Milk, homogenized			1,548	5,080			
Naphtha		0.76	1,225	4,019			
Natural Gas		0.316 (-103 °C)	753 (-103 °C)	2,470.5 (-153 °F)			
Nitrogen	N <sub>2</sub>	0.808 (-199 °C)	962 (-199 °C)	3,156.2 (-326 °F)		0.217 (-199 °C)	2.334 (-326 °F)
Oil, Car (SAE 20a.30)		1.74	870	2,854.3		190	2,045.093
Oil, Castor	C <sub>11</sub> H <sub>10</sub> O <sub>0</sub>	0.969	1,477	4,845.8	3.6	0.670	7.209
Oil, Diesel		0.80	1,250	4,101			
Oil, Fuel AA gravity		0.99	1,485	4,872	3.7		
Oil (Lubricating X200)			1,530	5,019.9			
Oil (Olive)		0.912	1,431	4,694.9	2.75	100	1,076.365
Oil (Peanut)		0.936	1,458	4,738.5			
Propane (-45 to -130 °C)	C <sub>3</sub> H <sub>8</sub>	0.585 (-45 °C)	1,003 (-45 °C)	3,290.6 (-49 °F)	5.7		
1-Propanol	C <sub>3</sub> H <sub>8</sub> O	0.78 (20 °C)	1,222 (20 °C)	4,009.2 (68 °F)			
2-Propanol	C <sub>3</sub> H <sub>8</sub> O	0.785 (20 °C)	1,170 (20 °C)	3,838.6 (68 °F)		2.718	29.245
Propene	C <sub>3</sub> H <sub>6</sub>	0.563 (-13 °C)	963 (-13 °C)	3,159.4 (9 °F)	6.32		
n-Propyl-alcohol	C <sub>3</sub> H <sub>8</sub> O	0.78 (20 °C)	1,222 (20 °C)	4,009.2 (68 °F)		2.549	27.427
Propylene	C <sub>3</sub> H <sub>6</sub>	0.563 (-13 °C)	963 (-13 °C)	3,159.4 (9 °F)	6.32		
Refrigerant 11	CCl <sub>3</sub> F	1.49	828.3 (0 °C)	2,717.5 (32 °F)	3.56		
Refrigerant 12	CCl <sub>2</sub> F <sub>2</sub>	1.516 (-40 °C)	774.1 (-40 °C)	2,539.7 (-40 °C)	4.24		
Refrigerant 14	CF <sub>4</sub>	1.75 (-150 °C)	875.24 (-150 °C)	2,871.6 (-268 °F)	6.61		
Refrigerant 21	CHCl <sub>2</sub> F	1.426 (0 °C)	891 (0 °C)	2,923.2 (32 °F)	3.97		
Refrigerant 22	CHClF <sub>2</sub>	1.491 (-69 °C)	893.9 (50 °C)	2,932.7 (122 °F)	4.79		
Refrigerant 113	CCl <sub>2</sub> F-CClF <sub>2</sub>	1.563	783.7 (0 °C)	2,571.2 (32 °F)	3.44		
Refrigerant 114	CClF <sub>2</sub> -CClF <sub>2</sub>	1.455	665.3 (-10 °C)	2,182.7 (14 °F)	3.73		
Refrigerant 115	C <sub>2</sub> ClF <sub>5</sub>		656.4 (-50 °C)	2,153.5 (-58 °F)	4.42		
Refrigerant C318	C <sub>4</sub> F <sub>8</sub>	1.62 (-20 °C)	574 (-10 °C)	1,883.2 (14 °F)	3.88		
Sodium nitrate	NoNO <sub>3</sub>	1.884 (336 °C)	1,763.3 (336 °C)	5,785.1 (637 °F)	0.74	1.37 (336 °C)	14.74 (637 °F)
Sodium nitrite	NoNO <sub>2</sub>	1.805 (292 °C)	1876.8 (292 °C)	6157.5 (558 °F)			
Sulphur	S		1177 (250 °C)	3861.5 (482 °F)	-1.13		
Sulphuric Acid	H <sub>2</sub> SO <sub>4</sub>	1.841	1,257.6	4,126	1.43	11.16	120.081



Tetrachloroethane	C2H2Cl4	1553 (20 °C)	1,170 (20 °C)	3,838.6 (68 °F)	1.19	12.804
Tetrachloro-ethene	C2Cl4	1.632	1,036	3,399		
Tetrachloro-Methane	CCl4	1.595 (20 °C)	926	3,038.1	0.607	6.531
Tetrafluoro-methane (Freon 14)	CF4	1.75 (-150 °C)	875.24 (-150 °C)	2,871.5 (-283 °F)	6.61	
Toluene	C7H8	0.867 (20 °C)	1,328 (20 °C)	4,357 (68 °F)	4.27	0.644
Toluol	C7H8	0.866	1,308	4,291.3	4.2	0.58
Trichloro-fluoromethane (Freon 11)	CCl3F	1.49	828.3 (0 °C)	2,717.5 (32 °F)	3.56	
Turpentine		0.88	1,255	4,117.5	1.4	15.064
Water, distilled	H2O	0.996	1,498	4,914.7	-2.4	1.00
Water, heavy	D2O		1,400	4,593		
Water, sea		1.025	1531	5023	-2.4	1.00

Temperature		Sound Speed in Water	
° C	° F	m/s	ft/s
0	32.0	1402	4600
1	33.8	1407	4616
2	35.6	1412	4633
3	37.4	1417	4649
4	39.2	1421	4662
5	41.0	1426	4679
6	42.8	1430	4692
7	44.6	1434	4705
8	46.4	1439	4721
9	48.2	1443	4734
10	50.0	1447	4748
11	51.8	1451	4761
12	53.6	1455	4774
13	55.4	1458	4784
14	57.2	1462	4797
15	59.0	1465	4807
16	60.8	1469	4820
17	62.6	1475	4830
18	64.4	1476	4843
19	66.2	1479	4853
20	68.0	1482	4862
21	69.8	1485	4872
22	71.6	1488	4882
23	73.4	1491	4892
24	75.2	1493	4899
25	77.0	1496	4908
26	78.8	1499	4918
27	80.6	1501	4925
28	82.4	1504	4935
29	84.2	1506	4941
30	86.0	1509	4951
31	87.8	1511	4958
32	89.6	1513	4964

33	91.4	1515	4971
34	93.2	1517	4977
35	95.0	1519	4984
36	96.8	1521	4984
37	98.6	1523	4990
38	100.4	1525	4997
39	102.2	1527	5010
40	104.0	1528	5013
41	105.8	1530	5020
42	107.6	1532	5026
43	109.4	1534	5033
44	111.2	1535	5036
45	113.0	1536	5040
46	114.8	1538	5046
47	116.6	1538	5049
48	118.4	1540	5053
49	120.2	1541	5056
50	122.0	1543	5063
51	123.8	1543	5063
52	125.6	1544	5066
53	127.4	1545	5069
54	129.2	1546	5072
55	131.0	1547	5076
56	132.8	1548	5079
57	134.6	1548	5079
58	136.4	1548	5079
59	138.2	1550	5086
60	140.0	1550	5086
61	141.8	1551	5089
62	143.6	1552	5092
63	145.4	1552	5092
64	147.2	1553	5092
65	149.0	1553	5095
66	150.8	1553	5095
67	152.6	1554	5099
68	154.4	1554	5099
69	156.2	1554	5099
70	158.0	1554	5099
71	159.8	1554	5099
72	161.6	1555	5102
73	163.4	1555	5102
74	165.2	1555	5102
75	167.0	1555	5102
76	167.0	1555	5102
77	170.6	1554	5099
78	172.4	1554	5099
79	174.2	1554	5099
80	176.0	1554	5099
81	177.8	1554	5099
82	179.6	1553	5095
83	181.4	1553	5095
84	183.2	1553	5095
85	185.0	1552	5092
86	186.8	1552	5092

87	188.6	1552	5092
88	190.4	1551	5089
89	192.2	1551	5089
90	194.0	1550	5086
91	195.8	1549	5082
92	197.6	1549	5082
93	199.4	1548	5079
94	201.2	1547	5076
95	203.0	1547	5076
96	204.8	1546	5072
97	206.6	1545	5069
98	208.4	1544	5066
99	210.2	1543	5063
100	212.0	1543	5063
104	220.0	1538	5046
110	230.0	1532	5026
116	240.0	1524	5000
121	250.0	1526	5007
127	260.0	1507	4944
132	270.0	1497	4912
138	280.0	1487	4879
143	290.0	1476	4843
149	300.0	1465	4807
154	310.0	1453	4767
160	320.0	1440	4725
166	330.0	1426	4679
171	340.0	1412	4633
177	350.0	1398	4587
182	360.0	1383	4538
188	370.0	1368	4488
193	380.0	1353	4439
199	390.0	1337	4387
204	400.0	1320	4331
210	410.0	1302	4272
216	420.0	1283	4210
221	430.0	1264	4147
227	440.0	1244	4082
232	450.0	1220	4003
238	460.0	1200	3937
243	470.0	1180	3872
249	480.0	1160	3806
254	490.0	1140	3740
260	500.0	1110	3642

## 8 Specification



- Transit-time correlation measurement
- Dual DSP-technology, coded signals for better measurement accuracy
- Wall mounted unit with graphic display
- Easy to install clamp-on sensors with no process interruption
- Non-invasive flow measurement of liquids or liquified gases
- Suitable for all commonly used pipe materials with pipe diameters from 10 mm (4/10") to 3 m (118")
- Two types of sensors to cover complete pipe range

### Description

The KATflow range of non-invasive flowmeters utilises ultrasonic technology for the accurate flow measurement of liquids and liquified gases in full pipes.

The KATflow 150 is designed for permanent installation on applications where advanced options and configurations are required. The flowmeter includes a variety of input and output options for diverse measurement requirements.

The measurement of flow is based on the principle that sound waves are influenced by a flowing medium. Measurements are made by penetrating the pipe with ultrasound and subsequently time differences, frequency variations and phase shifts of the ultrasonic signals are evaluated. This measuring technique has no effect on the flowing medium. There is no pressure loss in the pipe and no wear on components of the measuring device.

The ultrasonic sensors are clamped onto the outside of the pipe, thus eliminating the need to dismantle the pipework and interrupt the process. The KATflow 150 can be applied to any type of standard pipe carrying clean or dirty liquids and liquified gases.

### Advantages

- Low installation effort and costs
- Measurement is independent of fluid conductivity
- No pressure loss, no possibility of leakage
- Retrospective installation for existing plants possible
- No cutting of pipes necessary, no interruption of process, no plant shut down
- No additional fittings for maintenance required
- Hygienic measurement, no risk of contamination, suitable for ultra clean liquids
- No contact with medium, no risk of corrosion when used with aggressive media
- Cost advantages when used with large diameter pipes, high pressure systems, etc.

## Ultrasonic Flowmeter KATflow 150



### Specification

#### General

Measuring principle:	Ultrasonic time difference correlation principle
Flow velocity range:	0.01 ... 25 m/s
Resolution:	0.25 mm/s
Repeatability:	± 0.15 % of measured value ± 0.015 m/s
Accuracy:	Volume flow ± 1 ... 3 % of measured value depending on application, ± 0.5 % of measured value with process calibration Flow velocity ± 0.5 % of measured value
Turn down ratio:	1/100
Gaseous and solid content of liquid media:	< 10 % of volume

#### Flow transmitter

Enclosure:	Wall mounted housing
Degree of protection:	IP 66 according EN 60529
Operating temperature:	-10 ... 60 °C (14 ... 140 °F)
Housing material:	Plastic, ABS, Polycarbonate (transparent front door only)
Flow channels:	1 or 2
Power supply:	100 ... 240 V AC 50/60 Hz, 9 ... 36 V DC, specials upon request
Display:	LCD graphic display, 128 x 64 dots, backlit
Dimensions:	H 237 x W 258 x D 146 mm without cable glands
Weight:	Approx. 2.3 kg

**Flow transmitter (cont.)**

Power consumption	: < 5 W
Signal damping	: 0 ... 99 s
Measurement rate	: 10 ... 1000 s <sup>-1</sup>
Operating languages	: English, German, French, Spanish, Russian
Response time	: 1 s, faster rates upon request
Calculation functions	: Average/difference/sum

**Quantity and units of measurement**

Volumetric flow rate	: m <sup>3</sup> /h, m <sup>3</sup> /min, m <sup>3</sup> /s, l/h, l/min, l/s, USgal/h (US gallons per hour), USgal/min, USgal/s, bbl/d (barrels per day), bbl/h, bbl/min, bbl/s
Flow velocity	: m/s, ft/s, inch/s
Mass flow rate	: g/s, t/h, kg/h, kg/min
Volume	: m <sup>3</sup> , l, gal (US gallons), bbl
Mass	: g, kg, t
Heat flow	: W, kW, MW (only with heat quantity measurement option)
Heat quantity	: J, kJ, MJ (only with heat quantity measurement option)

**Internal data logger**

Storage capacity	: approx. 30,000 samples (128 kByte), optional > 100,000 samples (512 kByte)
Logging data	: All measured and totalised values, parameter sets

**Communication**

Serial interface	: RS 232, RS 485 (optional)
Data	: Instantaneous measured value, parameter set and configuration, logged data

**Software KATdata+**

Functionality	: Downloading of measured values/parameter sets, graphical presentation, list format, export to third party software, on-line transfer of measured data
Operating systems	: Windows 2000, NT, XP, Linux, Mac (optional)

<b>Process inputs</b>	: Galvanically isolated from main electronics and from other I/O's
Temperature	: PT 100, four-wire circuit, measuring range - 50 ... 400 °C, resolution 0.1 K, accuracy ±0.2 K
Current	: 0 ... 20 mA active or 4 ... 20 mA passive, U = 30 V, R <sub>i</sub> = 50 Ω, accuracy 0.1 % of MV

<b>Process outputs</b>	: Galvanically isolated from main electronics and from other I/O's
Current	: 0/4 ... 20 mA, active (R <sub>L</sub> < 500 Ω), 16 bit resolution, U = 30 V, accuracy = 0.1 %

Voltage	: Upon request, 0 ... 10 V, R <sub>i</sub> = 500 Ω
Digital (Open-Collector)	: Totaliser, value 0.01 ... 1000/unit, width 30 ... 999 ms, U = 24 V, I <sub>max</sub> = 4 mA
Digital (relay)	: Alarm, fault (programmable) Form C (SPDT-CO) contacts, U = 48 V, I <sub>max</sub> = 250 mA

**Clamp-on sensors****Type K1N, K1E**

Diameter range	: 50 ... 3000 mm
Dimensions	: 60 x 30 x 34 mm
Material	: Stainless steel
Temperature range	: <i>Type K1N</i> : -30 ... 130 °C (-22 ... 266 °F) <i>Type K1E</i> : -30 ... 200 °C (-22 ... 392 °F), for short periods up to 300 °C (572 °F)
Degree of protection	: IP 66 acc. EN 60529, IP 67 and IP 68 optional

**Type K4N, K4E**

Diameter range	: 10 ... 250 mm
Dimensions	: 43 x 18 x 22 mm
Material	: Stainless steel
Temperature range	: <i>Type K4N</i> : -30 ... 130 °C (-22 ... 266 °F) <i>Type K4E</i> : -30 ... 200 °C (-22 ... 392 °F), for short periods up to 300 °C (572 °F)
Degree of protection	: IP 66 acc. EN 60529, IP 67 and IP 68 optional

**Type K1Ex, K4Ex**

(for use in hazardous areas Zone 1 or 2)

Diameter range	: <i>Type K4Ex</i> : 10 ... 250 mm <i>Type K1Ex</i> : 50 ... 3000 mm
Dimensions	: 60 x 30 x 34 mm
Material	: Stainless steel
Temperature range	: -20 ... 120 °C
Degree of protection	: IP 66 acc. EN 60529
Protection concept	: Encapsulation
Certification code	: Ex mb IIC T4 - T6 The sensors are suitable for use in hazardous areas classified as Zone 1 and 2. The transmitter unit must be placed in the safe area.

## Appendix A

### Certificate of Conformity



**Katronic Technologies Ltd.**  
23 Cross Street  
Leamington Spa  
CV32 4PX  
GREAT BRITAIN

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Fax +44 (0)870 3000 111

E-mail [mail@katronic.co.uk](mailto:mail@katronic.co.uk)  
Web [www.katronic.co.uk](http://www.katronic.co.uk)

#### Declaration of Conformity

We, **Katronic Technologies Ltd.**, declare under our sole responsibility that the products listed below to which this declaration relates are in conformity with the EEC directives:

**EMC Directive 2004/108/EC for Electromagnetic Compatibility**  
**Low Voltage Directive 2006/95/EC for Electrical Safety**

##### Description of products:

Ultrasonic flowmeters KATflow 150, 200 and 230 with associated KATRONIC transducers

The mentioned products are in conformity with the following European Standards:

Class	Standard	Description
<b>EMC Directive</b>	BS EN 61326-1:2006	Electrical equipment for measurement, control and laboratory use - EMC requirements
<b>Immunity</b>	BS EN 61326-1:2006 BS EN 61000-4-2:1995 BS EN 61000-4-3:2006 BS EN 61000-4-4:2004 BS EN 61000-4-5:2006 BS EN 61000-4-6:1996 BS EN 61000-4-11:2004	Electrical equipment for continuous unattended use Electrostatic discharge RF field Electric fast transient/burst Surge RF conducted AC mains voltage dips and interruption
<b>Emission</b>	BS EN 61326-1:2006 BS EN 55022:2006	Electrical equipment Class B Disturbance voltage Class B
<b>Low Voltage Directive</b>	BS EN 61010-1:2001	Safety requirements for electrical equipment for measurement, control and laboratory use

Leamington Spa, 01 September 2007

For and on behalf of **Katronic Technologies Ltd.**

*Karsten Frahn*

Karsten Frahn  
Managing Director



Reg. No. GB03/58999

Registered in England No. 3296028 • Registered Office as above

## Appendix B



### Customer Return Note (CRN)

Company  Address   
Name   
Tel. No.   
E-mail

Instrument model  Katronic contract no.   
Serial number  (if known)  
Sensor type(s)   
Sensor serial number(s)

The enclosed instrument has been used in the following environment (please  $\surd$ ):

Nuclear radiation ☐  
Water-endangering ☐  
Toxic ☐  
Caustic ☐  
Biological ☐  
Other (please specify)

We confirm (\* delete if not applicable)

- that we have checked the instrument and sensors are free of any contamination\*,
- neutralised, flushed and decontaminated all parts which have been in contact with hazardous substances and/or environments\*,
- that there is no risk to man or environment through any residual material.

Date   
Signature   
Company stamp